ARGONNE NATIONAL LABORATORY

TRANSPORTATION TECHNOLOGY R&D CENTER

Assessment of Well-to-Wheels Energy Use and Greenhouse Gas Emissions of Fischer-Tropsch Diesel

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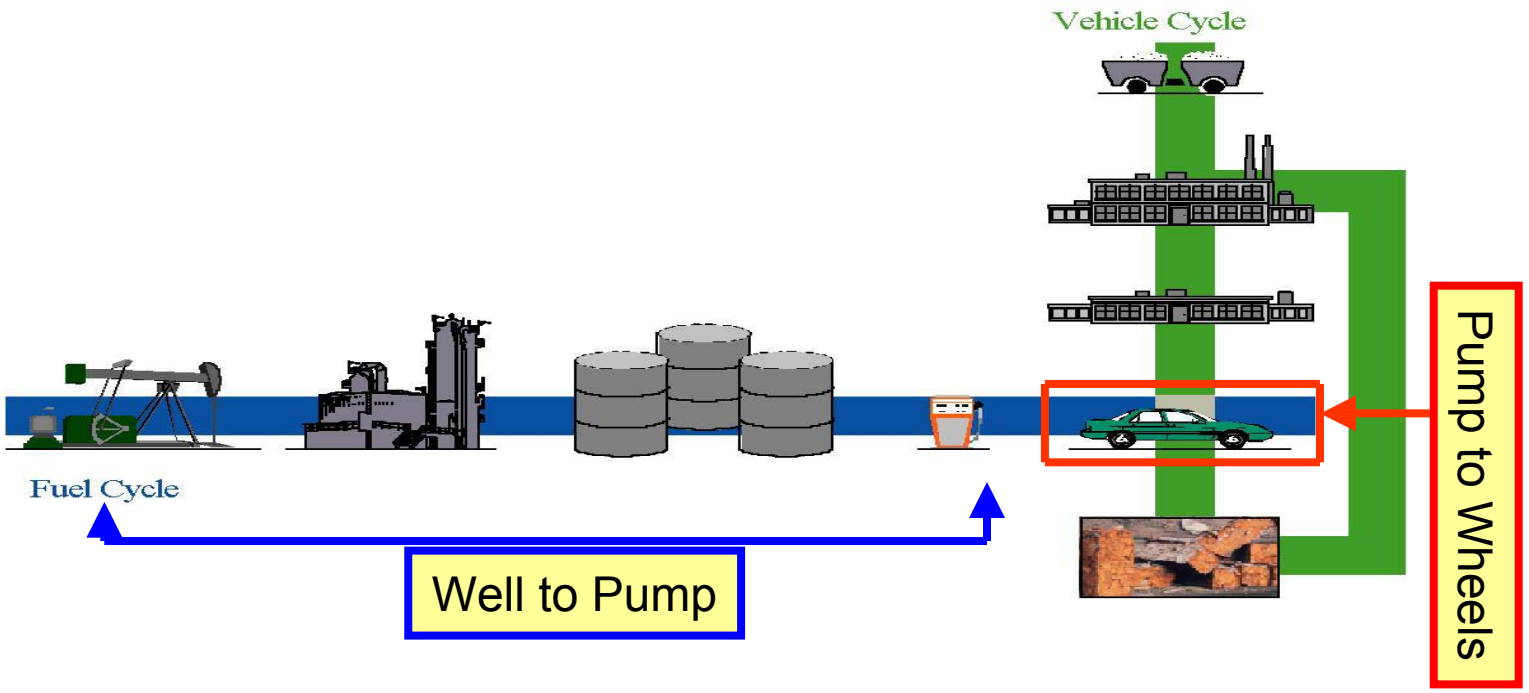
Workshop on Fischer-Tropsch Diesel Rulemaking
Office of FreedomCar and Vehicle Technologies
U.S. Department of Energy

Washington, D.C., October 16, 2002

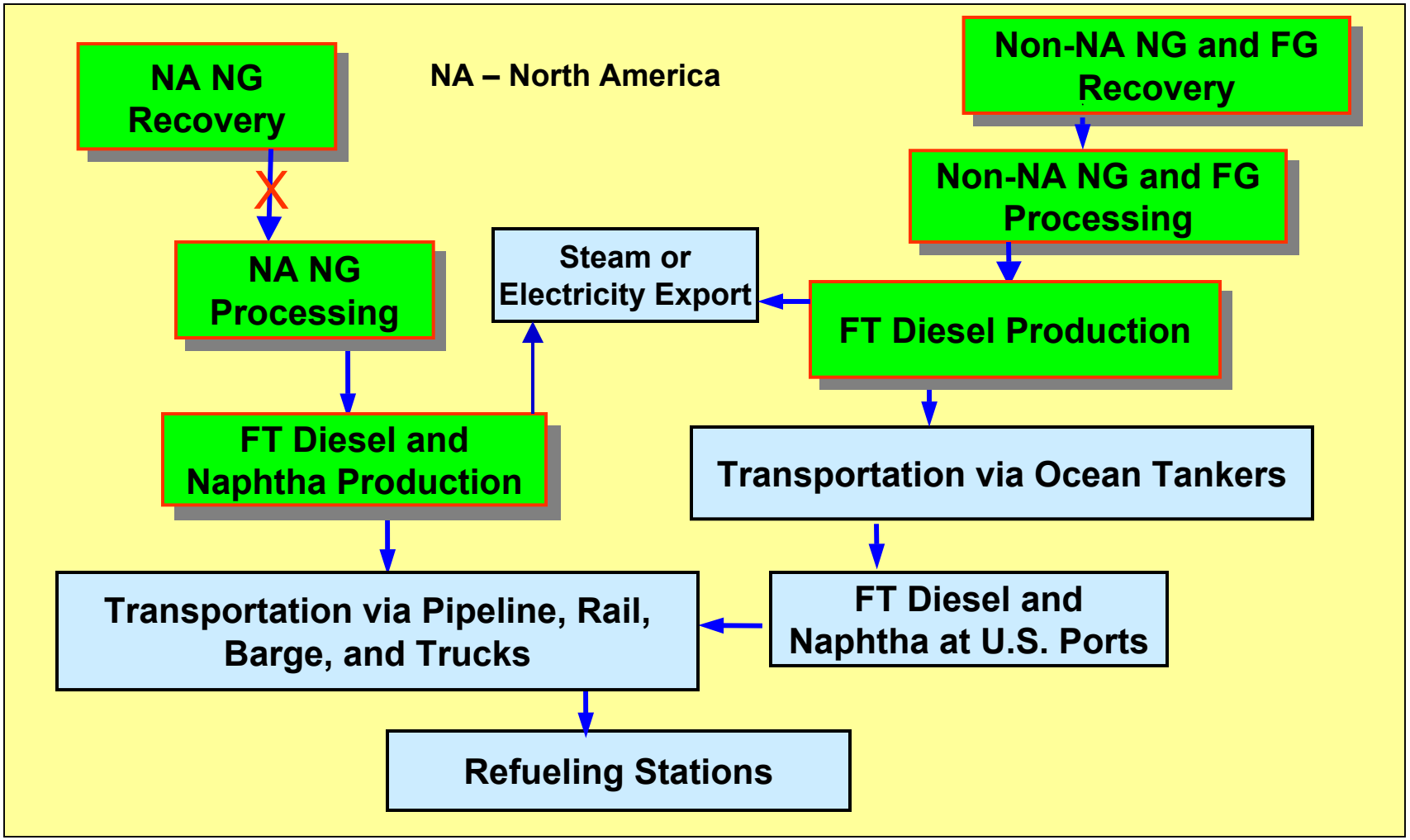
GREET Was Used for This Study



Argonne developed the GREET (Greenhouse gases, Regulated Emissions, and Energy use in Transportation) model for WTW analyses

- The GREET model and its documents are available at **http://greet.anl.gov**
- There are about 350 GREET users worldwide including governmental agencies, industries, universities, and research institutions

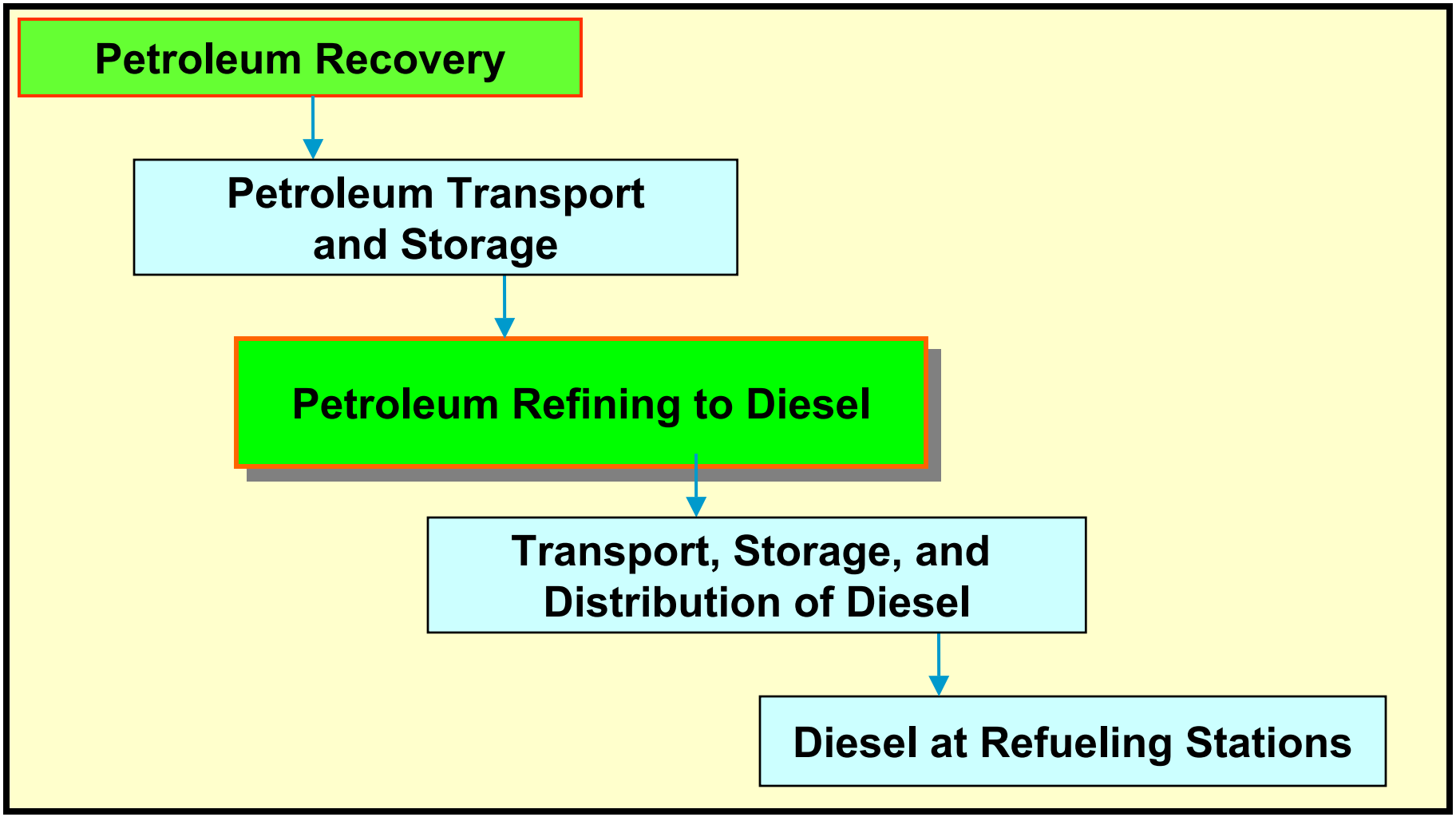
WTP Stages of Fischer-Tropsch Diesel



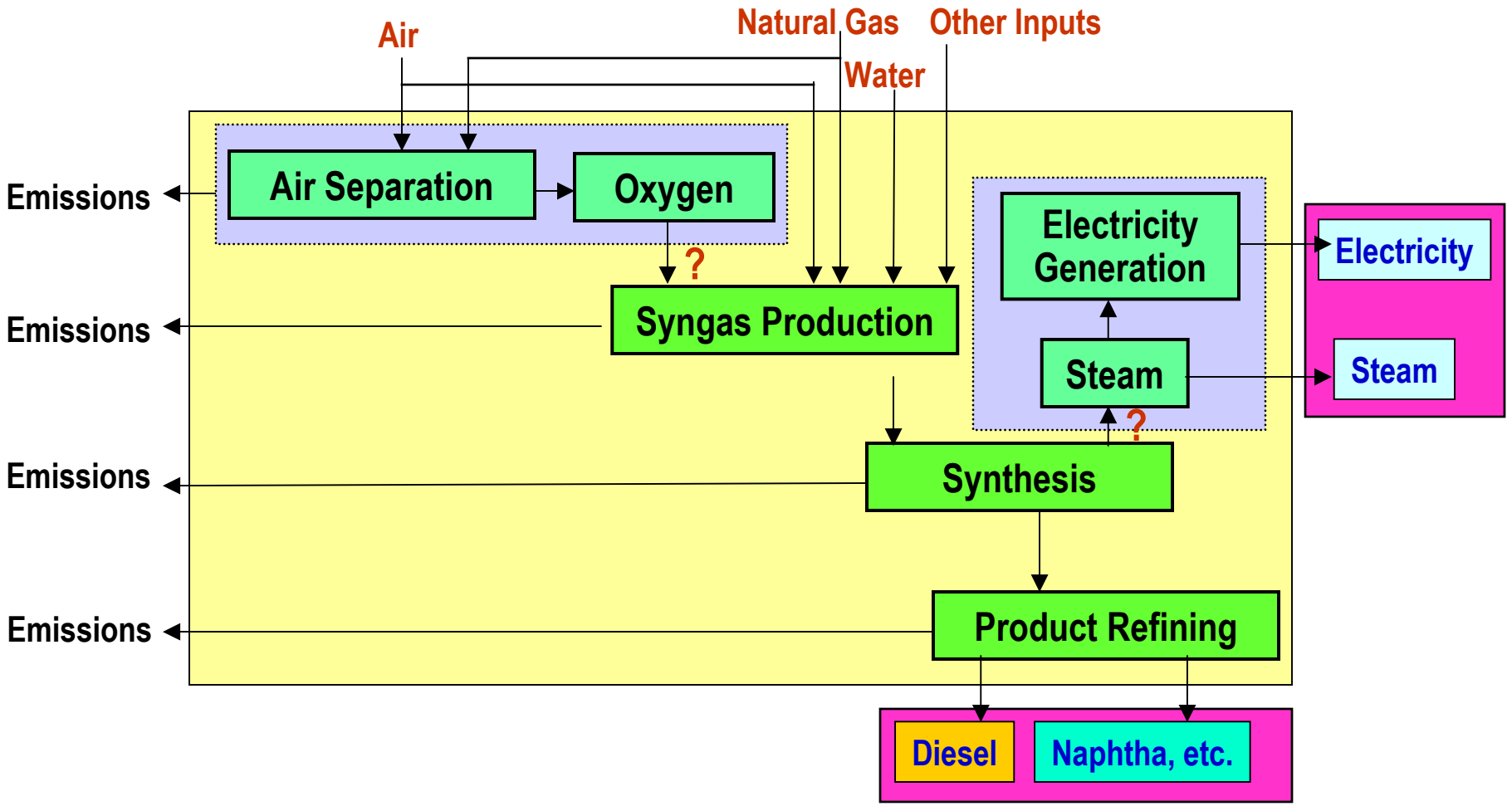
Key Issues for Estimating FTD WTW Energy Use and GHG Emissions

- Energy and carbon efficiencies of FTD plants (efficiencies are defined as output energy or carbon divided by input energy or carbon)
- FTD plant general designs
  - Standalone to produce FTD, naphtha, and other products
  - Co-generation of steam and/or electricity for export outside of plants
- Post-synthesis refining choices
  - Affect product slate and product quality
  - Ultimately affect WTW energy efficiencies and GHG emissions
- Natural gas feeds
  - North American gas
  - Non-North American gas
  - Non-North American flared gas
- Combustion efficiencies of FTD vehicles (which was not addressed in Argonne's study)

WTP Stages of Petroleum Diesel Fuel Cycle



Boundary of FTD Plants for WTP Assessment

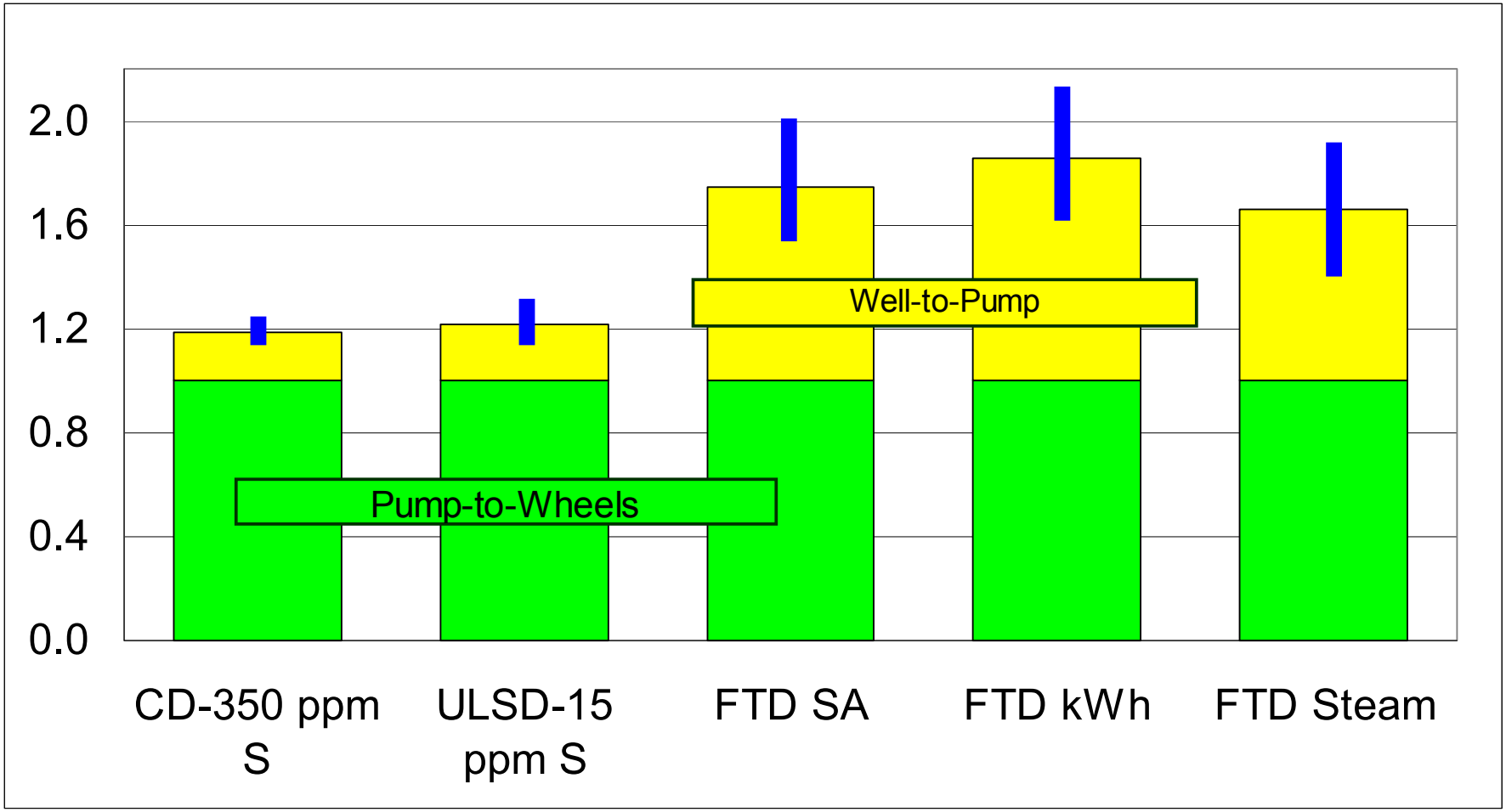


? here means optional

Key Parametric Assumptions in This Study

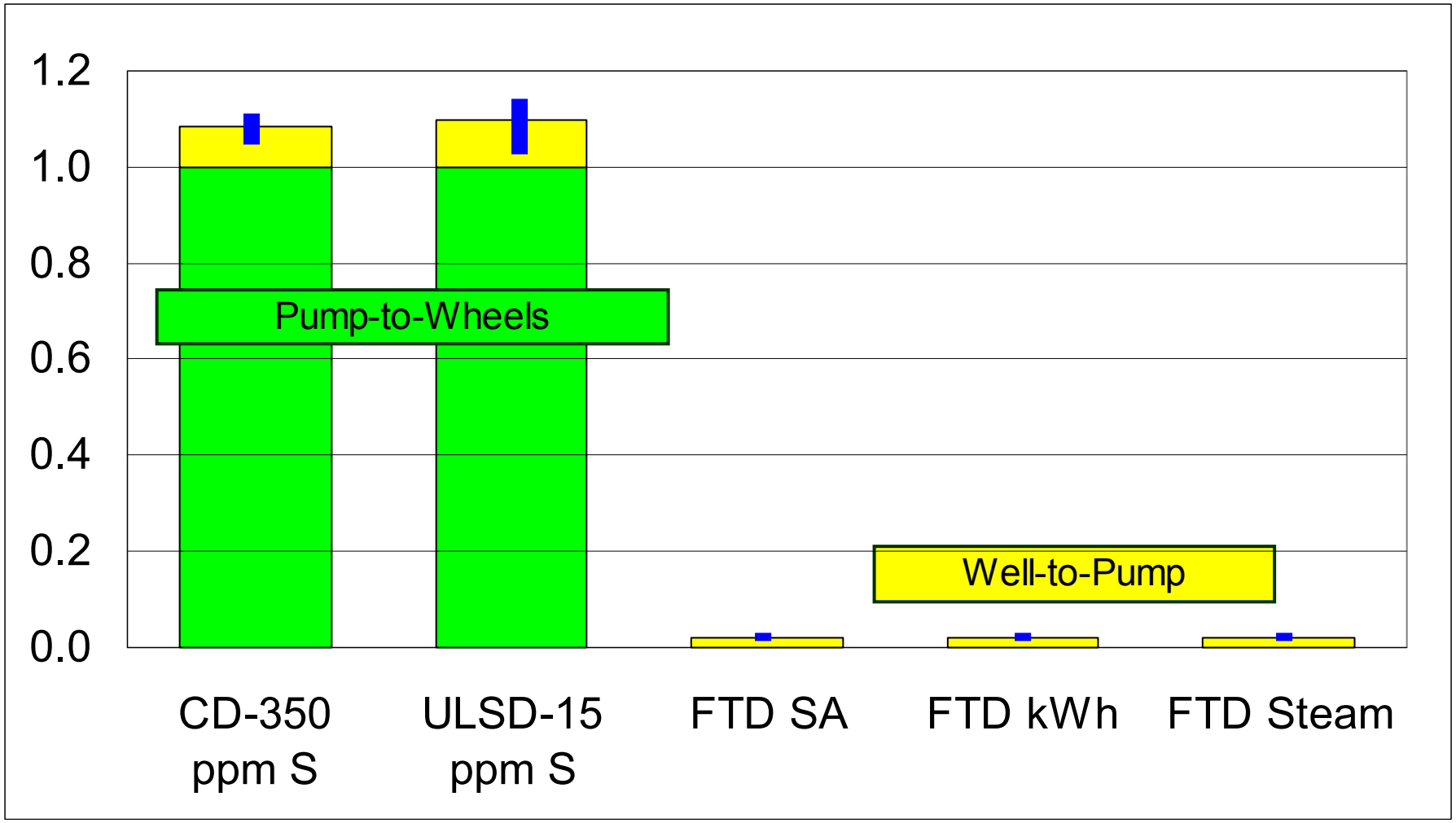
	Min	Mean	Max
Petroleum recovery efficiency (%)	96.0	98.0	99.0
Diesel refining efficiency (%): 350 ppm S	88.0	89.0	90.0
Diesel refining efficiency (%): 15 ppm S	85.0	87.0	89.0
NG recovery efficiency (%)	96.0	97.5	99.0
NG processing efficiency (%)	96.0	97.5	99.0
Standalone FTD plant efficiency (%)	54.0	61.0	68.0
Electric co-gen. FTD plant: efficiency (%)	49.0	53.0	57.0
Electric credit: kWh/10^6 Btu produced	16.6	23.6	30.5
Steam co-gen. FTD plant: efficiency (%)	49.0	53.0	57.0
Steam credit: 10^3 Btu/10^6 Btu produced	189	268	347
FTD plant carbon efficiency (%)	62.5	71.3	80.0

WTW Total Energy (Virtually All Fossil Energy) Results: 10^6 Btu/10^6 Btu Produced and Used

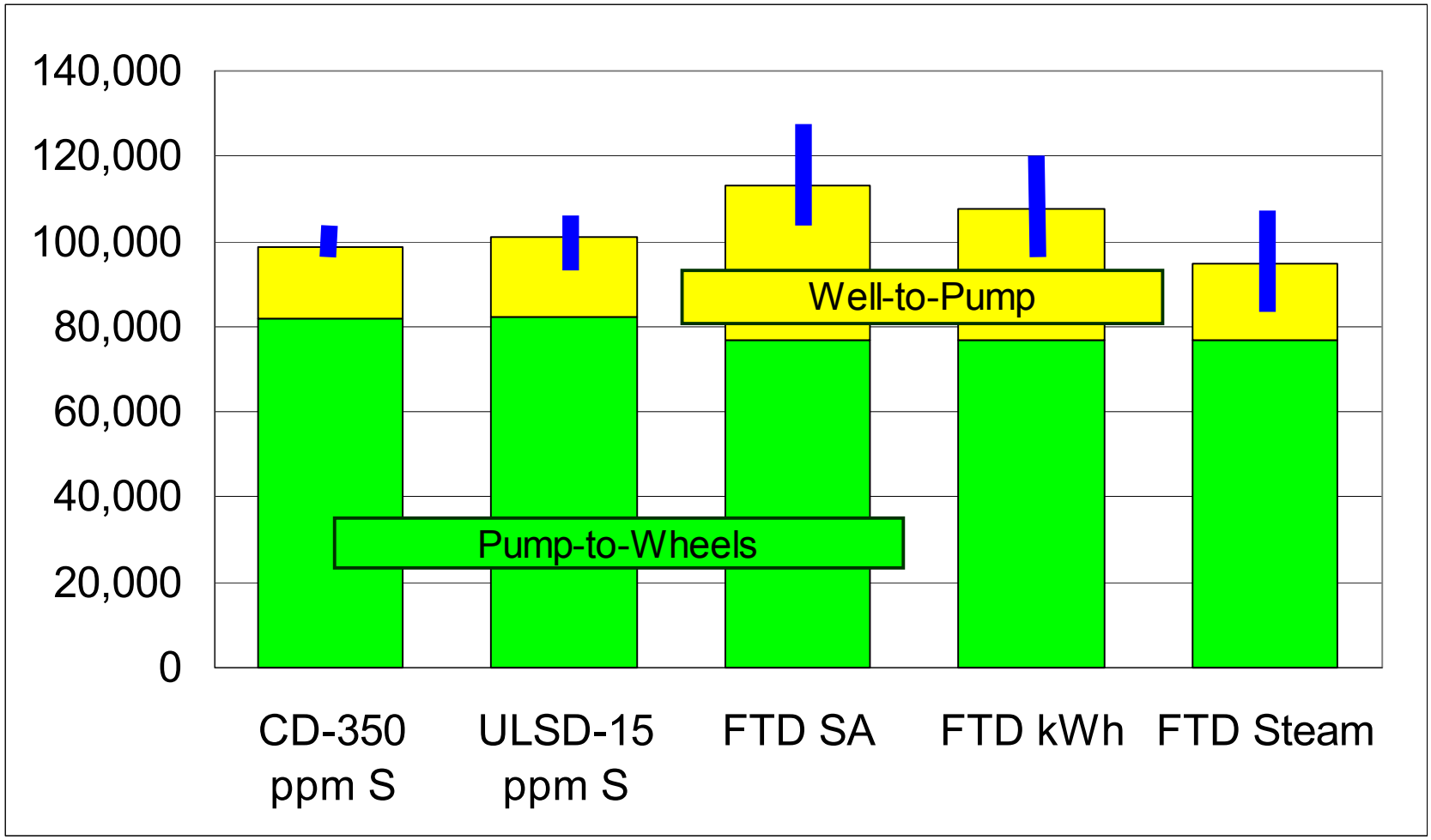


Flare

WTW Petroleum Use Results: 10^6 Btu/10^6 Btu Produced and Used



WTW GHG Emissions Results: grams/10^6 Btu Produced and Used



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Conclusions

- For each unit of FTD available for use in vehicles, its production consumes more total energy and fossil energy than production of petroleum diesel
- However, use of FTD almost eliminates petroleum use, relative to use of petroleum diesel
- Production of FTD causes higher GHG emissions than refining petroleum diesel. With export of steam and/or electricity, however, GHGs can be reduced to levels comparable to petroleum diesel

Note: Use of otherwise flared gas results in large energy and GHG emission reduction benefits

Conclusions (cont.)

- Combustion of FTD yields lower GHGs than combustion of petroleum diesel
- WTW GHGs from FTD appear to be typically somewhat higher than for petroleum diesel but in the most favorable cases they can be comparable or somewhat lower

Note: calculations do not reflect differential in per mile Btu consumption